

Consciousness & Sleep





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Sleep Physiology

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INTENDED LEARNING OBJECTIVES (ILO)



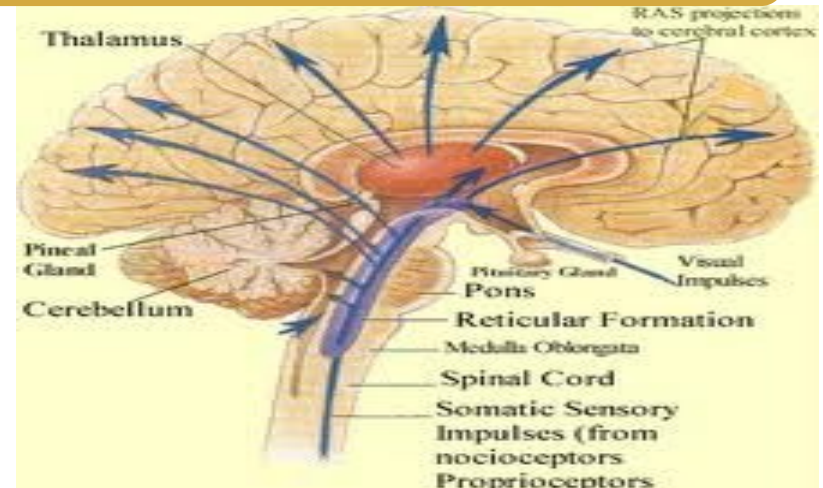
By the end of this lecture the student will be able to

1. List physiological changes during sleep.
2. Compare & contrast types of sleep.
3. Discuss the mechanisms (theories) of sleep.
4. Explain the sleep/wakefulness cycle

Consciousness (*Wakefulness*)



✓ It is the awareness of both self & one's surroundings, thoughts and feelings.



✓ **Produced** by general excitation of the cerebral cortex as a result of activation of ARAS. **RF** \square **NSTN** \square **generalized (+) cerebral cortex**
(*Reticulo-thalamo-cortical pathway*)

✓ **Maintained** by +ve feedback mechanism through re-excitation of ARAS by signals from the activated **Cerebral cortex** \square **NSTN** \square **RF**
(*Cortico-thalamo-reticular pathway*)

Sleep



- ✓ It is a physiological state of *temporary* unconsciousness from which person can be aroused by sensory or motor stimuli.



- ✓ Its duration varies inversely with age (average 18 hours in infants, 8 hours in adults and 6 hours in old persons).

PHYSIOLOGICAL CHANGES DURING SLEEP:



- ↓ Heart rate.
- ↓ Vasomotor tone.
- ↓ Blood pressure.



- ↓ rate & depth of breathing.
- ↓ pulmonary ventilation with a



- ↑ ↑ ↑ GIT secretions.
- Most of endocrine secretions ↓ except **Growth hormone** ↑ during

- ↓ Body temperature.
- ↓ Basal metabolic rate.



- Sensory perception.
- Voluntary movement.
- Reflexes are abolished except a **+ve Babiniski sign..**
- ↓ Muscle tone except **ocular**

Mechanisms of sleep



Sleep result from depression of cerebral cortex 2ry to inhibition of ARAS which can occur by either:

1- Passive theory of sleep:

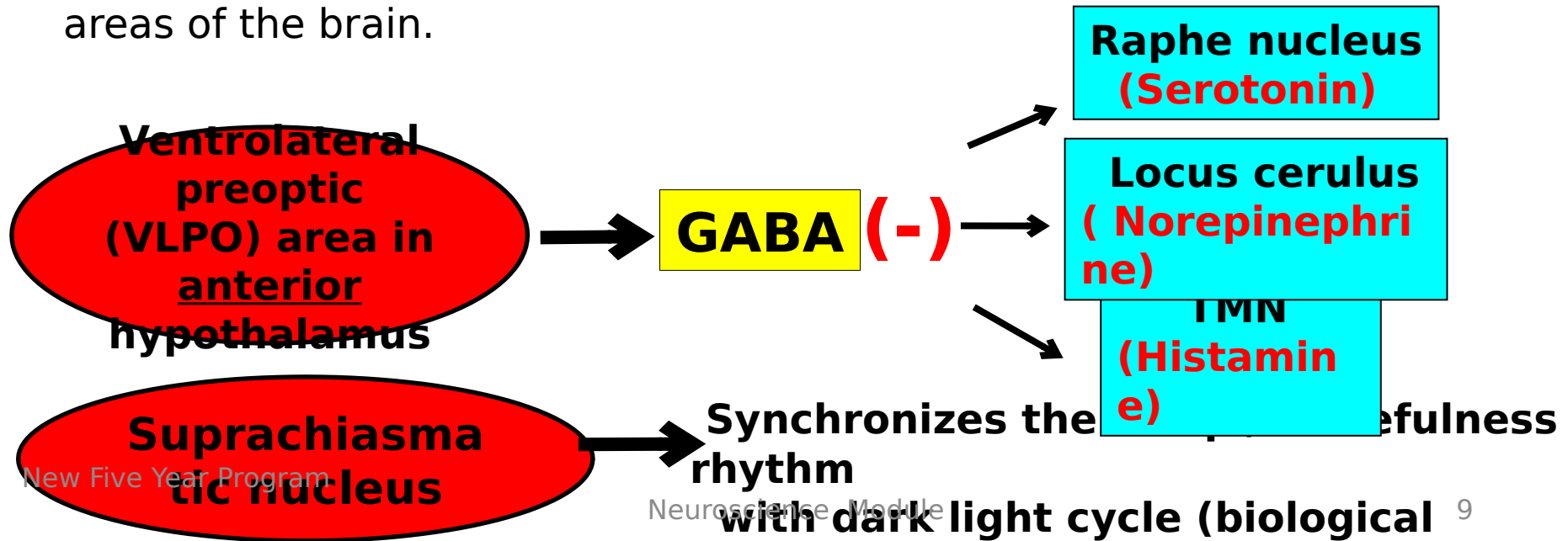
Sleep is caused by passive (-) of ARAS.

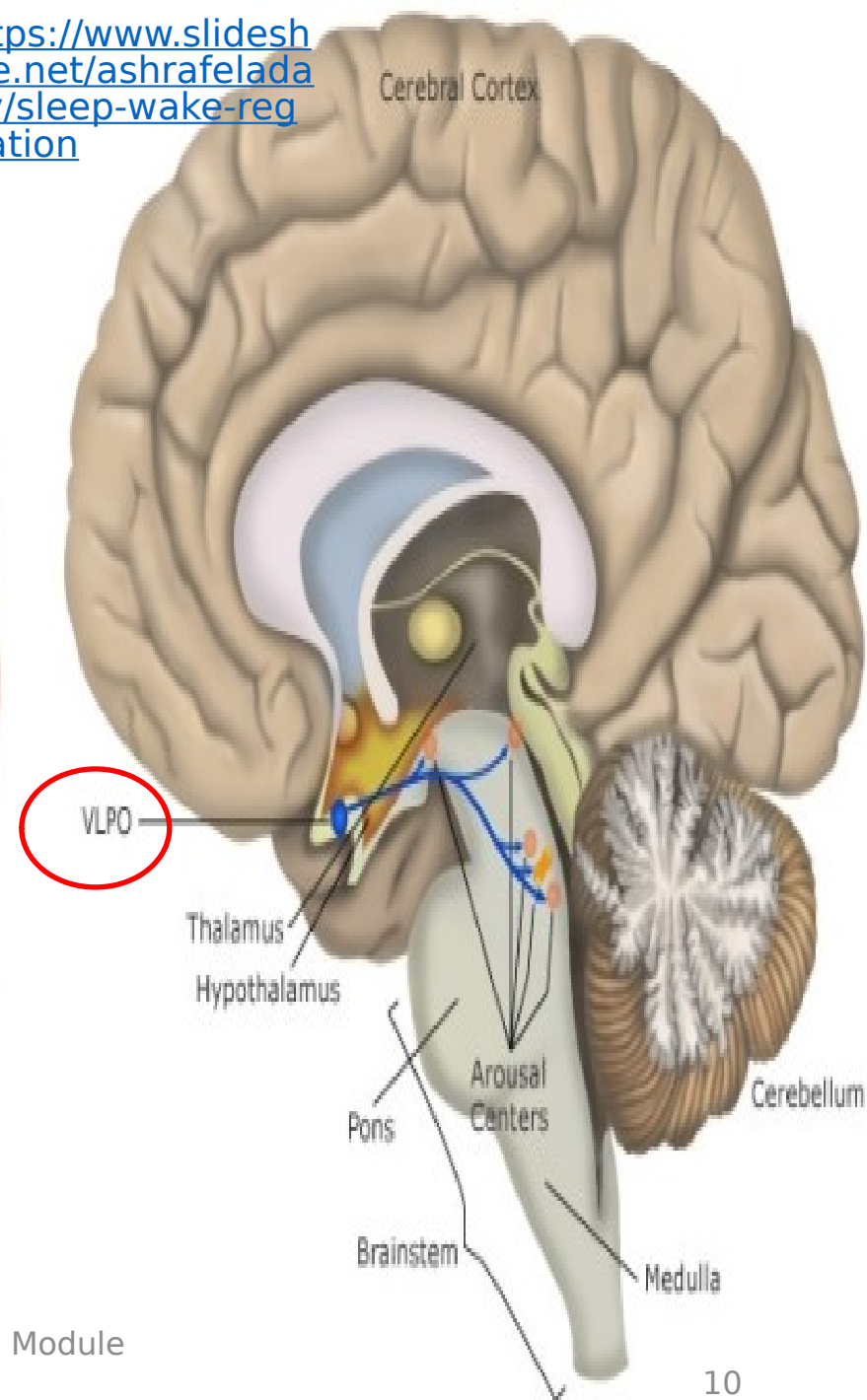
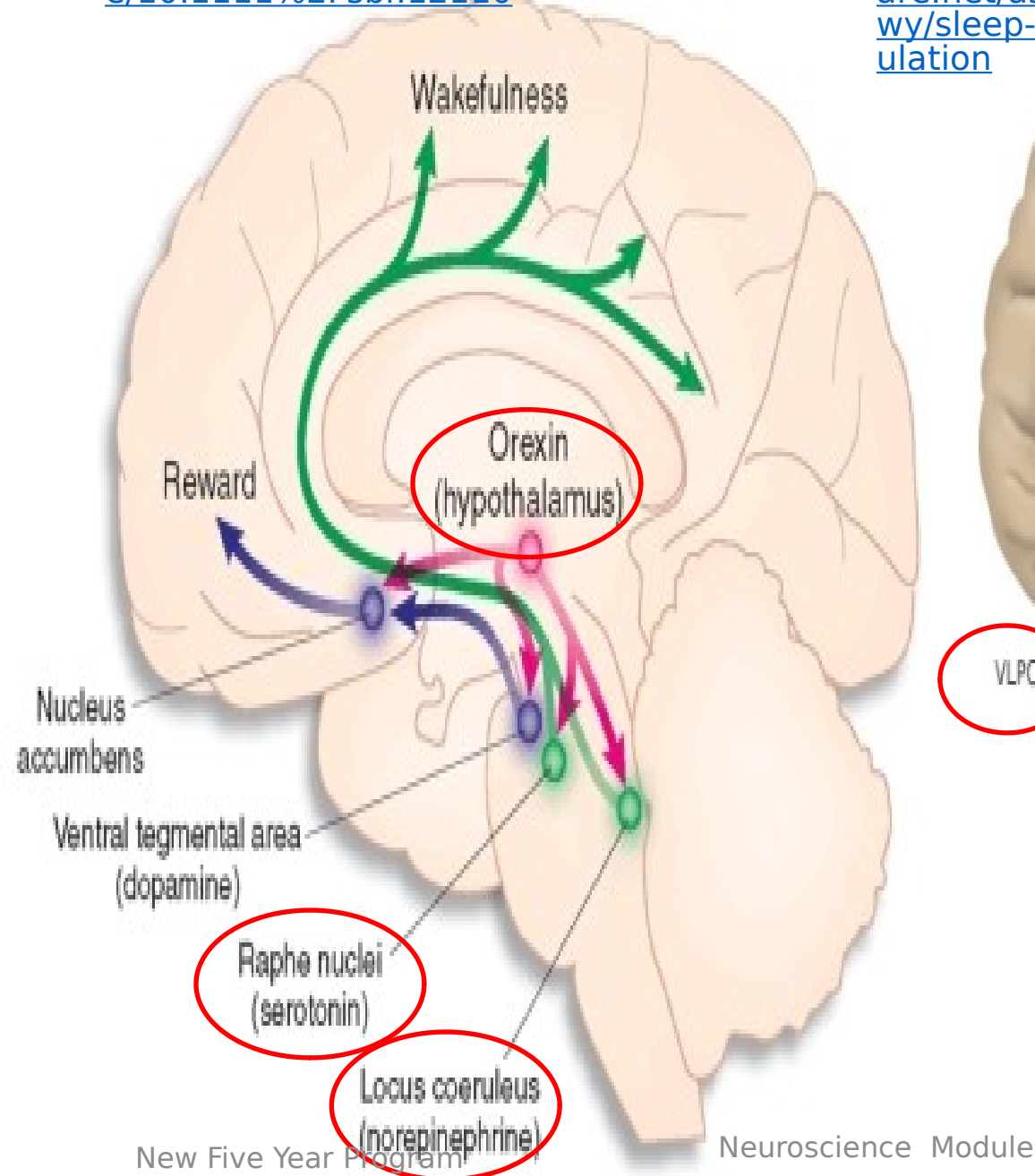
- by fatigue after a period of wakefulness
- by elimination of exciting stimuli.



2-Active theory of sleep:

- Many areas with their neurotransmitters are involved in (+) of RAS producing wakefulness as
 - **Noradrenaline** from locus cerulus.
 - **Serotonin** from raphe nucleus.
 - **Orexins** from hypothalamus (LHA).
 - **Histamine** from post. Hypothalamus (TMN).
- Orexins** producing neurons projects from the lateral hypothalamus. They strongly excite arousal centers e.g the norepinephrine and histamine systems as well as the cerebral cortex itself with important role in wakefulness.
- Sleep is caused by active inhibition of ARAS by stimulation of specific areas of the brain.





CATEGORY	NUCLEUS	NEURO-TRANSMITTER	LEVEL OF ACTIVITY	
			during arousal	during sleep
sleep-promoting	VLPO	GABA	0	++
arousal-promoting	LC	norepinephrine	++	0
arousal-promoting	Raphe	serotonin	++	0
arousal-promoting	TMN	histamine	++	0
orexin-releasing	LHA	orexin	++	0



zzzz

GABA

Orexin



NE, Serotonin,
Histamine

Sleep/wakefulness cycle

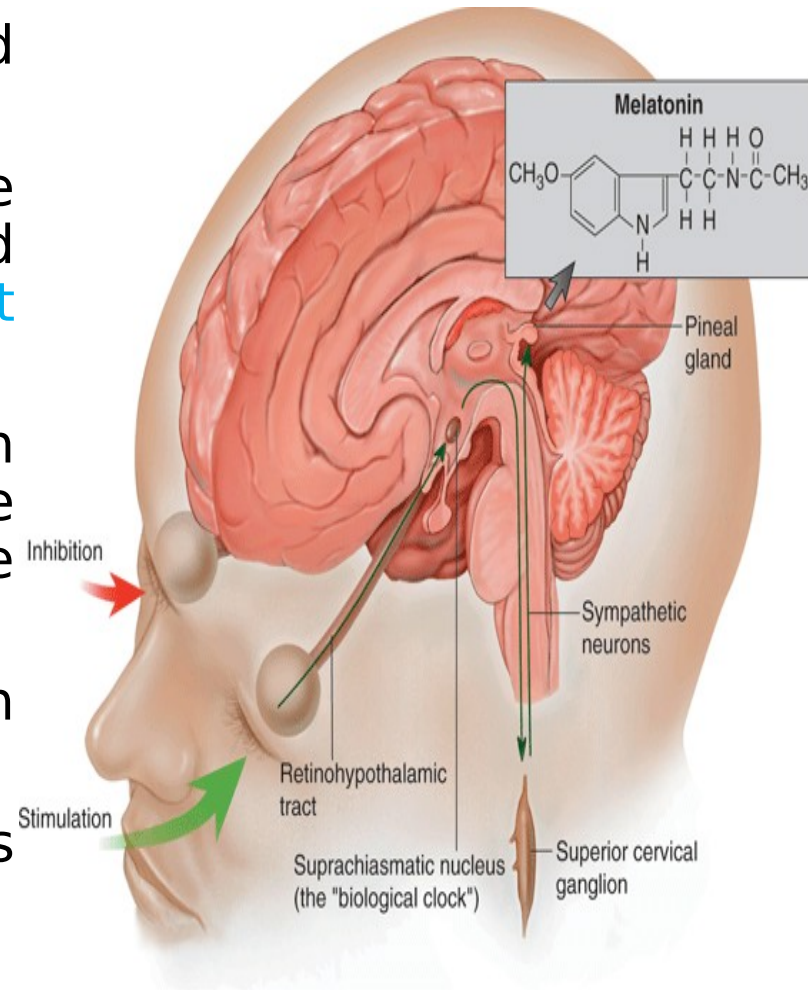


- Once wakefulness is initiated , it is maintained by +ve feedback excitation of ARAS.
- After wakefulness continue for several hours, sleep occurs due to:
 - 1- Fading away of the +ve FB cycle d.t fatigue of RAS.
 - 2- Activation of sleep centers which (-) RAS.
- During the sleeping hours:
 - 1- ARAS gradually recovers its excitability.
 - 2- Sleep centers become less active.
- So, ARAS is released from their (-) effect & discharge to the cerebral cortex□ new cycle of wakefulness.

Melatonin and sleep- wake state



- Melatonin released from pineal gland plays a role in sleep mechanisms.
- Melatonin synthesis and secretion are ↑ during the dark hours and maintained at a ↓ level during daylight hours.
- The diurnal change in melatonin secretion may function to coordinate events with the light-dark cycle in the environment.
- Retinohypothalamic fibers synapse in the suprachiasmatic nuclei (SCN)
 - sympathetic preganglionic neurons in the spinal cord
 - superior cervical ganglion.
 - Postganglionic neurons project
 - the pineal gland
 - melatonin secretion

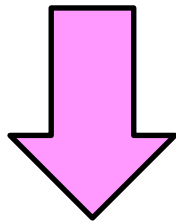


Source: Barrett KE, Barman SM, Boitano S, Brooks H: *Ganong's Review of Medical Physiology*, 23rd Edition: <http://www.accessmedicine.com>

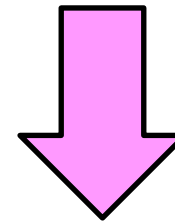
Types of Sleep



- There are 2 types of sleep that alternate in a cyclic manner during sleep.



**Slow wave sleep
non- rapid eye movement
sleep
= non-REM**

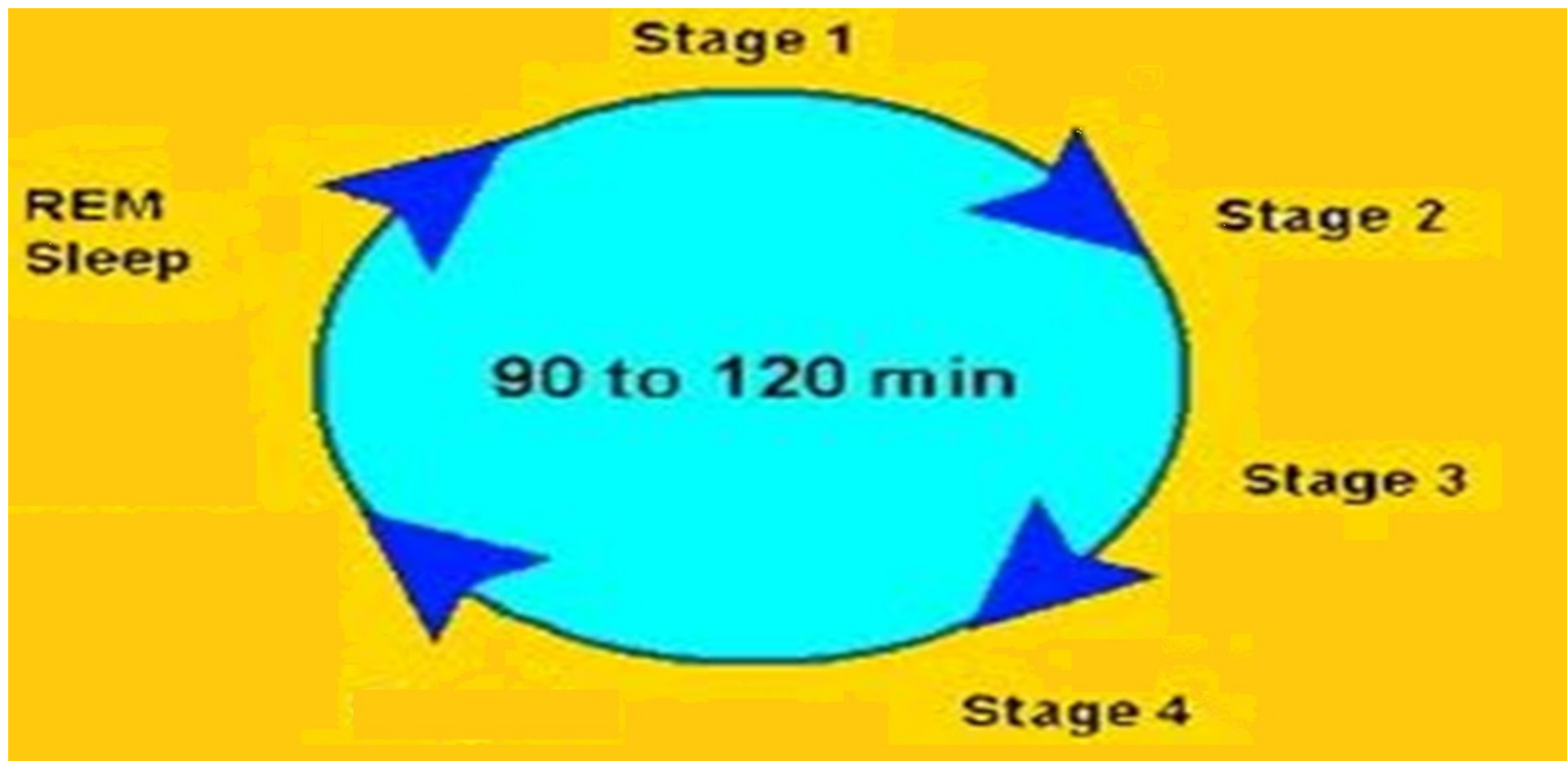


**Rapid eye movement
sleep
= REM**

Types of Sleep



Sleep occurs in cycles of NREM-REM sleep, each lasting approximately 90-110 minutes.



Types of Sleep



**Slow wave sleep
(SWS)
= non-REM**

**Rapid eye
movement sleep
= REM**

Timing

**At the start of sleep
~90 minutes
(80% of the total
sleeping time)**

**After 4th stage of
non REM
~20 minutes
(20% of the total
sleeping time)**

**Eye
movements**

**Eye deviates up
+ miosis**

**Rapid eye
movement**

Importance

Physical rest

Mental rest

**Autonomic
changes**

**↓ HR, ABP, RR & BMR
(relative ↑
parasympathetic
activity).**

**↑ HR, ABP,.....
(↑ sympathetic
activity).**

Types of Sleep



	Slow wave sleep (SWS) = non-REM	Rapid eye movement sleep = REM
Growth hormone	↑	↓ compared to non-REM
Sleep talking, walking & nocturnal enuresis	Present	Absent
Dreams	Present but not remembered	Active remembered dreams
Teeth grinding	Absent	Present
Muscle tone	↓	Marked ↓ ↓ ↓ (Paradoxical Sleep)

Types of Sleep



**Slow wave sleep
(SWS)**

= non-REM

**Rapid eye
movement sleep**

= REM

**Threshold
of
arousal**

**Low
Four stages:**

High

**EEG
change
s**

Stage 1: very light sleep (theta waves)

Stage 2: light sleep (sleep spindles within theta)

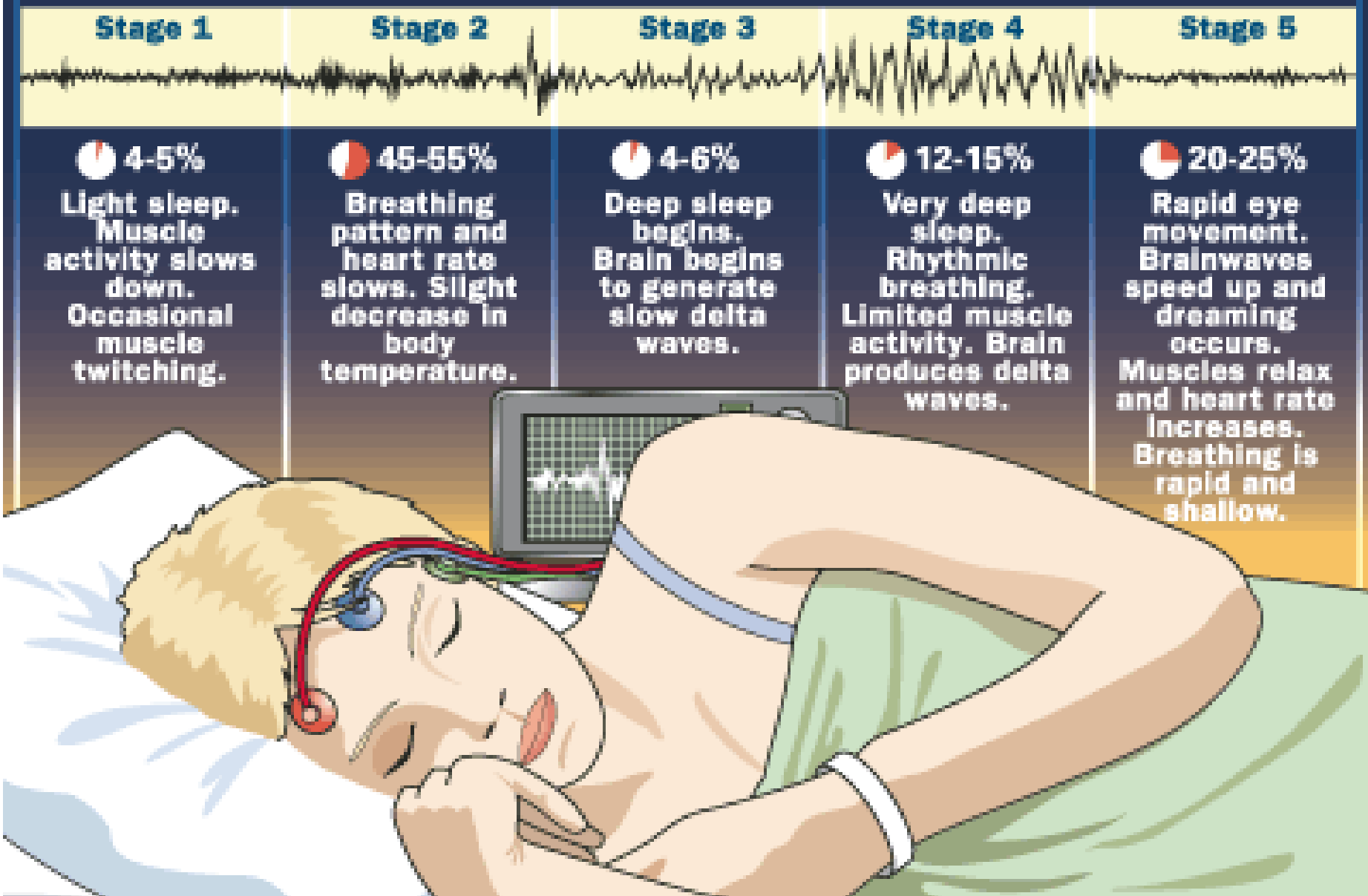
Stage 3: moderately deep sleep (delta waves)

Stage 4: Sleep is deepest (delta waves with maximal slowing)

B waves like that in alert state (desynchronized beta rhythm).

Also called **paradoxical sleep** because it indicates marked brain activity but person is still asleep.

100% Sleep Cycle

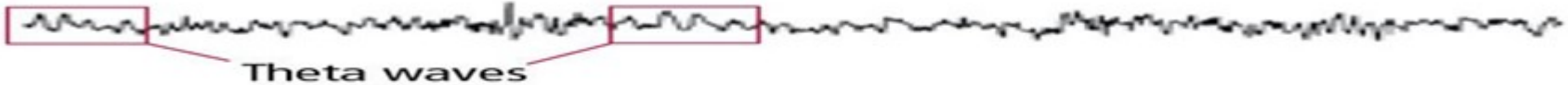


RELAXED WAKEFULNESS

Alpha waves



STAGE N1



STAGE N2



STAGE N3 or DEEP SLEEP



REM or DREAMING SLEEP



Brain waves change dramatically during the different stages of sleep.

<https://www.helpguide.org/harvard/biology-of-sleep-circadian-rhythms-sleep-stages.htm>

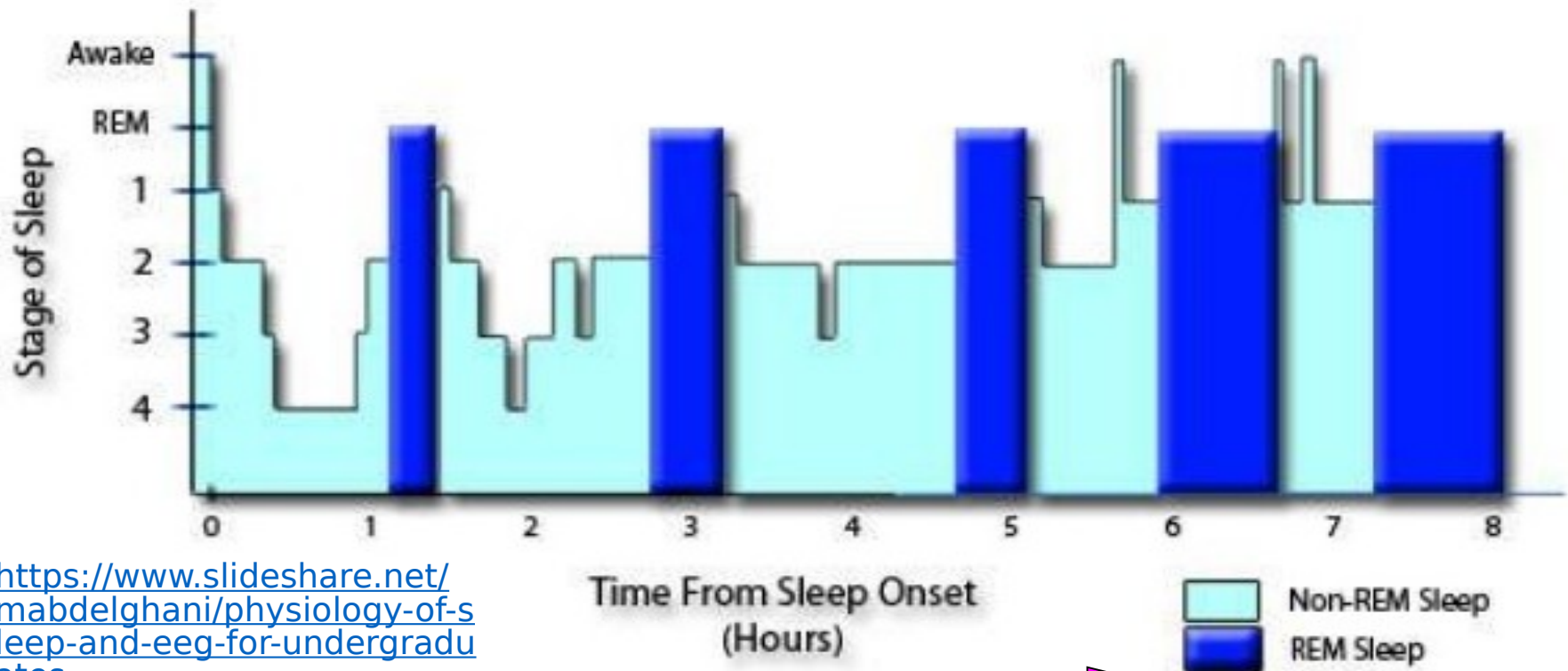
Distribution of sleep stages



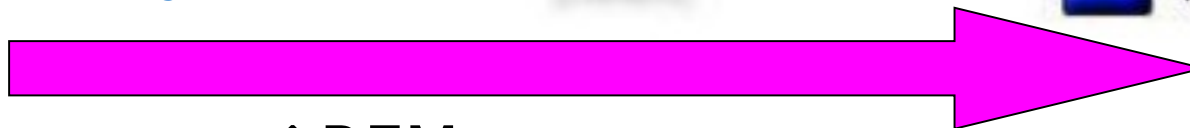
- Sleep starts normally by the slow wave type for about 90 minutes, then REM sleep follows for about 20 minutes.
- This is repeated cyclically *with gradual prolongation of the RFM sleep periods and less stage 3 and 4 sleep* towards morning.
- Therefore there are 4-6 sleep cycles *during a single night and the REM sleep constitutes 20 % of total sleep time.*

DISTRIBUTION OF SLEEP STAGES

Sleep Stages Through The Night



<https://www.slideshare.net/mabdelghani/physiology-of-sleep-and-eeeg-for-undergraduates>



↑ REM
↓ SWS (stage 3&4)

SUGGESTED TEXTBOOKS



- ❖ Ganong's Review of Medical Physiology , 23rd edition, Chapter 15.
- ❖ Guyton & Hall: Textbook of Medical Physiology, 12e
[pages: 1349-1353]

thank you!

